

## **Mitigation of High Ground-water Problems Using a Hydraulic Optimization Model of San Bernardino Valley, California**

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A decrease in agricultural ground-water usage combined with above-average recharge has caused formerly swampy areas to reappear in San Bernardino Valley, California. As a result, urbanized areas within the 100-square-mile basin are now confronted with high ground water. The increase in hydrostatic pressure near the land surface within a 10 –square-mile area have caused a variety of problems including buckled foundations, severed utility lines, and the treat of liquifaction in a region susceptible to earthquakes.

Linear programming techniques coupled with ground-water response matrices were used to determine the most efficient pumping program to dewater the affected areas. The ground-water system was simulated using a transient, two-layer, finite-element model. Initial results of the management model indicated that the existing capacity of municipal wells and pipelines was insufficient to accomplish the dewatering within the required 1-year time frame. Therefore, different combinations of existing and proposed facilities were evaluated. Because ground-water levels are close to the land surface, all pumping solutions are strongly dependent on changes in the evapotranspiration rate, which varies with the depth to water. To account for these changes, an iterative technique was developed that permits the inclusion of piecewise linear source/sink functions such as evapotranspiration in an otherwise linear problem. This method combines an optimal pumping solution with the background response of the ground-water system, and then adjusts the bounds on individual pumping rates in order to formulate the next iteration of the problem.

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